

DYNAMIC ADJUSTMENT AND LONG-RUN ECONOMIC STABILITY

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INTRODUCTION

A fixed exchange rate regime implies restrictions on economic policy. If the policy is not in line with long-run equilibrium, the outcome is generally a balance of payment crisis that results in a realignment of the exchange rate target. This paper uses a continuous time macroeconomic model (CONTIMOS) to analyse the stability of the adjustment process of the Swedish economy during the 1980s.¹ The study builds on the assumption that a necessary condition for maintaining a fixed exchange rate regime is that the economy has a stable steady state solution in the long run. The aim is to identify the parameters that are crucial for the existence and the stability of a steady state solution of the Swedish economy, conditional on the basket exchange rate regime.

Between 1977 and 1992 Swedish authorities fixed the value of the krona towards a basket of foreign currencies. In May 1991, stressing the will to bring the Swedish inflation in line with that of the European Community, the authorities decided to peg the krona closer to the German mark by changing the composition of the foreign exchange rate index so that Sweden became unilaterally attached to the European Monetary System. In November 1992, following repeated speculative attacks, the authorities were forced to give up the basket system and let the krona float. Before the floating began, the krona had been devaluated twice within the basket system, by 10% in October 1981 and 16% in November 1982. The latter devaluation was considered to be in excess of market equilibrium and aimed at boosting the domestic economy.

¹The model is a respecified version of CONTIMOS — a continuous time macroeconomic model of Sweden presented in Sjöö (1992).

Abstract

This paper studies the adjustment process of the Swedish economy during the 1980s. The aim is to identify factors that are important for the stability of the adjustment process. The results are based on a continuous time macroeconomic model, that is linearized around its steady state. The results show that the adjustment processes of domestic prices and interest rates are important for a possible saddle point solution. It is likely, therefore, that disturbances in the adjustment process of these variables give rise to devaluation expectations since their long-run steady state positions are determined with respect to corresponding foreign variables and the fixed exchange rate regime. *Ceteris paribus*, a slower adjustment speed of domestic prices destabilizes the system, while a slower adjustment speed of domestic interest rates is stabilizing. To the extent that the central bank has been able to slow down the adjustment speed of Swedish interest rates this policy has been stabilizing. The results indicate that the economy is rather insensitive to a faster adjustment speed in net foreign assets. *Ceteris paribus*, an increased liberalization of international capital flows is not destabilizing.

Keywords: Continuous time; Macroeconometrics; Eigenvalues; Sensitivity analysis.

Several studies report lack of credibility of the Swedish basket regime during the 1980s. Looking at intervention figures of the Swedish central bank (Riksbanken) Franzén and Sardelius [8] conclude that expectations about a revaluation caused an inflow of currency in October 1984, while speculations about devaluations caused outflows of capital and high Swedish interest rates during 1985. Capital flows and interest rate differences motivated by devaluation expectations were also observed between 1987 and 1992. Svensson [13] studies interest rate differentials, and shows the existence of expectations concerning devaluations within the coming 12 month period during, October 1987 to January 1988, and during November 1989 to January 1990. Lindberg, Svensson and Söderlind [11], using more refined methods, find devaluation expectations during the whole period 1982 to 1990, except for 1984. Loureiro and Sjöö [10], estimate the systematic ex post excess returns on the forward market for Swedish kronor versus German marks. They show that the returns were not significantly smaller during the 1980s than they were in the 1970s, despite the ambition to follow a fixed exchange rate policy during the latter period.

The question is whether there is anything in the adjustment process that explains these devaluation expectations. The stochastic differential system estimated in this paper can be seen as a formalization of how agents with bounded rationality learn about inconsistencies in the economic adjustment process under a fixed exchange rate regime. The model is based on monthly data over the period 1982:06 to 1988:06. This is a period with no realignments in the basket regime that ends just when some studies report a lack of credibility of the krona. The results of this paper suggest that the joint determination of long-run equilibrium in the money market and the growth of government debt is crucial for the existence of a steady state solution. Further, the stability of the solution

is sensitive to the adjustment speeds of domestic prices and interest rates.

Given an econometric model in continuous time, questions about long-run adjustment and stability can be investigated as follows. The first step is to calculate the steady state solution and derive the restrictions it implies on and between the parameters of the model. In the second step the model is estimated, and the empirical parameters are compared with those required for a steady state solution. Significant deviations suggest sectors of the economy that are out of line with a steady state solution.

In the third step, we assume that the estimated parameters are those of a steady state solution. The model is then linearized around its assumed steady state and, its stability is examined through the eigenvalues of the model. Stability is here understood as negative eigenvalues, which means that the economy continues to adjust towards its steady state solution after a shock. In this context a saddle point solution can be understood as the need to change economic policy, or adjust the exchange rate, if certain sectors of the economy are exposed to shocks.

Finally we investigate how sensitive the stability of the model is to small parameter changes. This step is of particular interest since it leads to an understanding of how a stable steady state solution might be facilitated by economic policy.

The paper is organized as follows. The first section presents the equations of the econometric model. The long-run steady state solution of the model, and the restrictions this solution implies on the parameters of the model are derived in the second section. The estimated parameters are presented in the third section. Deviations between the estimated parameters of the model and those given by the steady state solution are discussed in section four. Linearization of the

system around its steady state is performed in the fifth section. The stability of the system, and its sensitivity to small changes in parameter values are investigated in sections six and seven. Conclusions and a summary are given in the final section.

1. A CONTINUOUS TIME ECONOMETRIC MODEL FOR SWEDEN – CONTIMOS.

CONTIMOS is a mixed order stochastic differential system, including fourteen stochastic equations and seven identities. The model can be described as an error correction model in continuous time, where each endogenous variable adjusts towards its assumed long-run equilibrium.² Econometric models specified in continuous time offer several advantages. Among other things the temporal aggregation bias arising from mixing both stock and flow data in the same model is reduced. It is not necessary to assume that all agents in the economy have the same planning horizon. Instead estimation is done under the assumption that agents' decision periods overlap in a stochastic way. There are no constraints on the adjustment speeds in the model, other than that they should be finite. Thus, the estimated time of adjustment may be shorter than the length of time between the observation points. Moreover, these models have a steady state solution, which greatly simplifies the dynamic analysis. Finally, the continuous time estimation technique makes use of *a priori* information about the growth of each variable so that the number of estimated parameters is

²The estimation technique for structural continuous time models is described in detail in Gandolfo [5] and Bergstrom [2].

reduced substantially.

The model is presented in Tables 1 and 2. The first table shows the long-run equilibrium relations,

$$\log \mathbf{y}^* = f(\log \mathbf{y}, \log \mathbf{z}, \boldsymbol{\beta}), \quad (1)$$

where \mathbf{y} and \mathbf{z} are vectors of endogenous and exogenous variables, $\boldsymbol{\beta}$ is the long-run parameters of the system, and a star indicates that the right-hand side represents the long-run equilibrium of the left-hand side variable. Table 2 shows the adjustment process associated with each endogenous variable,

$$D \log \mathbf{y} = \boldsymbol{\alpha} \log(\mathbf{y}^*/\mathbf{y}) + \boldsymbol{\epsilon}, \quad (2)$$

where $\boldsymbol{\alpha}$ is a vector of adjustment parameters and $\boldsymbol{\epsilon}$ is a residual process assumed to be $\boldsymbol{\epsilon} \sim \text{NID}(0, \boldsymbol{\Sigma})$. Substitution of (1) into (2) leads to a stochastic differential system. Though not explicitly specified, all variables in the model are assumed to be continuous functions of time.

TABLE 1 ABOUT HERE.

TABLE 2 ABOUT HERE.

TABLE 3 ABOUT HERE.

Most long-run relationships are familiar log linear relationships of macroeconomic models. The first equation describes the level of private consumption (c) as a function of a constant term (γ_1), real domestic income (y_d), and the nominal domestic interest rate (R_d). Upper case letters indicate nominal

values and lower case letters deflated values.

Demand for exports (x), Equation (1:2), is determined by foreign income (y_f) and the price gap between export prices (P_x) and the foreign price level (P_f), measured in domestic currency through the efficient foreign exchange rate (ES).³ In a similar way, imports (1:3) are given by the domestic income and the difference between domestic and import price levels ($P_d/ES P_i$). The foreign exchange rate is determined through the balance of payments identity, (1:18), where D is the derivative with respect to time $D \equiv d/dt$, NFA and RFX are net foreign assets held by the private and the government sectors respectively. RFX includes the net holdings of both the Riksbank and the government.

In (1:17) desired stock of inventories (v) is assumed to be a simple function of domestic income. Two prices are determined in the model, the domestic price level and the price of exports, both are functions of the foreign exchange rate and the foreign price level, (1:5) and (1:6). The long-run domestic interest rate is determined by uncovered interest rate parity, (1:7). The expected future foreign exchange rate (EF), approximated by an effective forward rate, is determined by the price gap between domestic and foreign price levels, (1:14). The foreign price is expressed in domestic currency by using the midpoint of the target zone of the foreign exchange rate (ET). Expectations are also influenced by the interest rate differential and the spot exchange rate.

Nominal government income (T), and expenditure (GE) are given by nominal income, (1:8) and (1:9). The difference between these variables is equal to the change in government debt, while the infinite sum of differences by definition makes up the level of government debt, as in (1:16).

³The foreign exchange rates in the model are constructed as efficient indices using the same weights as the currency basket of the Riksbank.

The financial block of the model is made up of five variables: money ($M3$), government bonds, private banks advances to the non-bank public, net foreign assets held by the private sector and net foreign assets held by the government and the central bank (RFX). Of these variables, the level of bank advances (A) is the most difficult one to model, (1:10). Deregulations of the credit markets in 1986 caused an almost explosive growth in advances during the sample, which ruins the estimation of any meaningful long-run level of this variable. The long-run stock of advances is therefore set to a hypothetical constant value (κ), such that the model determines the long run growth in advances (see below).

The stock of net foreign assets held by the private sector (NFA) is determined by differences between the domestic interest rate and its long-run equilibrium value, (1:11). Net holdings are also affected by the gap between the spot foreign exchange rate index and its midpoint target zone value. As long as the foreign exchange rate system is credible, the gap shows the future course of the exchange rate. The closer the rate comes to an endpoint the more likely it is that it will change in the opposite direction. In (1:12), the total net holdings of foreign assets by the government and the central bank (RFX), reflect the need to finance part of the government debt abroad to preserve both the fixed exchange rate and the level of foreign exchange reserves in the long run.

The stock of government bonds held by the private non-bank sector (1:13) is determined by the size of the government debt. Furthermore, deviations from the midpoint of the target zone reflect the need to sterilize changes in foreign exchange reserves. Positive values of the parameter of (ET/ES) are associated with a relatively stronger currency within the band and an inflow of currency.

The adjustment processes, to the long-run relations described by (1:1) – (1:18) are described in Table 2. The residual process is assumed to be independent white noise, $\epsilon \sim \text{NID}(0, \Sigma)$. The order of each stochastic differential equation is determined by the order of integration associated with the endogenous variable. Adjustment processes of slowly adjusting variables, $I(2)$ variables, are modeled as second order differential functions.⁴ Therefore, the adjustment towards the long-run equilibrium for advances, net foreign assets held by the government sector, and non-bank holdings of government bonds are all modeled by second order processes. The remaining variables are adjusting according to first order differential equations.

Some variables are modeled residually from the identities in the model. In each identity all exogenous terms are included in the terms labelled statistical discrepancy (SD). These terms are constructed so that the left-hand side equal to the right-hand side even after the model is transformed into its linearized discrete analogue. The first identity, links changes in financial variables together through what might be called a money supply identity, (2:15). The identity says that changes in the stock of money increases by the part of government debt that is financed in the banking sector ($DGD - DB$), increases in bank advances (DA) and a reduction the net foreign assets held by the government and the central bank. Changes in government debt are given by government expenditure minus government income, (2:26). The balance of payments identity (1:18) is used to solve for the foreign exchange rate. Finally, from the income identity changes in inventories are given residually by (2:17).

⁴The order of integration was determined by using augmented Dickey–Fuller and Dickey–Pantula tests. The results are available on request.

The final step is to formulate how real and financial buffer stocks affect the adjustment process. At each moment, changes in inventories and money are given by identities (2:17) and (2:15). Agents are assumed to regulate their holdings of money through private consumption, net purchases of government bonds, or changes in bank advances.⁵ Money's role as a buffer stock is represented by the inclusion of an excess demand for money expression in the equation for private consumption, (2:1). The adjustment of money balances is also influencing the adjustment of government bonds and bank advances, see (2:10) and (2:13). In the equations for consumption and bonds, (2:1) and (2:13), the negative signs of the adjustment parameters α_2 and α_{20} , suggest that an excess demand for money leads to a reduction in the growth of private consumption and holdings in government bonds.

A similar way of reasoning, to that of the money stock, can be applied to inventories. When changes in inventories are determined by the income identity (2:17), excess holdings of inventories are left to affect the paths of imports and production, as in (2:3) and (2:4).

2. THE STEADY STATE SOLUTION OF THE MODEL.

Each endogenous variable in the model is specified so that it adjusts towards its long-run equilibrium value, or is determined residually as the outcome of processes in other markets. It is natural to extend the discussion and ask whether the whole system will converge to a stable steady state equilibrium.

⁵In an open economy, agents can also trade with foreign assets. This effect is not specified as it was not supported by the data.

In a steady state solution, variables must grow at constant proportional rates. For a solution to be stable, the parameters of the system must fulfill certain constraints. The equation for the domestic price level (2:5), is an example. When domestic and foreign prices grow at the same rate, β_3 must equal unity, which means that purchasing power parity should hold in the long run.

Questions about the steady state can only be addressed in a linear model. Remember that an alternative specification, or an alternative set of parameters might lead to different conclusions about the long-run solution. Also, a steady state solution is only one possible reference path which the model can be said to converge to. In matrix form the system can be written as,

$$Dy(t) = A(\theta)y(t) + B(\theta)z(t), \quad (3)$$

where $A(\theta)$ and $B(\theta)$ are matrices of parameters, θ is a vector of structural parameters of interest $\theta = \{\alpha, \beta, \gamma, \nu\}$, and y and z are vectors of endogenous and exogenous variables, respectively. This is a non-autonomous system since it contains exogenous variables. The time paths of these variables are assumed to be known functions of time,

$$z = f^*(t). \quad (4)$$

Given the function that generates the steady state time path of the exogenous variables in (4), the steady state solution of $y(t)$ in (3) is given by the solution of,

$$y^*(t) = f^*(\theta, t), \quad (5)$$

that satisfies

$$D\mathbf{y}^*(t) = \mathbf{A}(\boldsymbol{\theta}) \mathbf{y}^*(t) + \mathbf{B}(\boldsymbol{\theta}) f^*(t). \quad (6)$$

The steady state solution of the system can be found by applying the method of undetermined coefficients. Assume that all variables in the system $\{\mathbf{y}, \mathbf{z}\}$ grow at constant rates such that $y_i(t) = y_i^* e^{\rho_i t}$, where y_i^* represents the initial value of variable, ρ_i is its growth rate and t is time. By fixing the growth rates and the initial values of the exogenous variables, the steady state solution can be found as a particular solution of the differential system. The values of \mathbf{y}^* and $\boldsymbol{\rho}$ are then solved for a given set of (estimated) parameters $(\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \boldsymbol{\nu})$. Once the steady state initial levels and growth rates of the exogenous variables are set to $\mathbf{z} = \mathbf{z}^* e^{\boldsymbol{\lambda} t}$, we get two sets of equations.

$$\boldsymbol{\rho} = \mathbf{g}(\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\lambda}), \quad (7)$$

$$\mathbf{y}^* = \mathbf{G}(\mathbf{z}^*, \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \boldsymbol{\rho}). \quad (8)$$

The solution to the first set (7) is relatively trivial, while that of the second can be quite complex. Both sets of solutions imply constraints on the parameters that should be satisfied in order for (7) and (8) to represent the steady state values of the system. To analyse the dynamics, the model has to be linearized around its long-run steady state solution. The eigenvalues of this linearized

system allow us to study the long-run dynamics of the economy.⁶ Given equations (6), (7) and (8), linearization leads to the following general system,

$$D\mathbf{x}(t) = \mathbf{A}(\boldsymbol{\theta}) \mathbf{x}(t) + f(\mathbf{x}, \mathbf{z}, \mathbf{B}(\boldsymbol{\theta}), t), \quad (9)$$

where $\mathbf{x} = \mathbf{y}(t) - \mathbf{y}^*$ is a vector of deviations from the long-run solution, and $f(\cdot)$ represents all higher order terms in the Taylor expansion. A necessary condition for asymptotic (local) stability is that all characteristic roots of the matrix \mathbf{A} have negative real parts, and that $|f(\mathbf{x}, \mathbf{z}, \mathbf{B}(\boldsymbol{\theta}), t)|/|\mathbf{x}|$ uniformly tends to zero in t as \mathbf{x} tends to zero. The eigensystem of (9) is,

$$\boldsymbol{\Lambda} = \mathbf{H}^{-1} \mathbf{A} \mathbf{H}, \quad (10)$$

where $\boldsymbol{\Lambda}$ is a diagonal matrix of eigenvalues (μ_j) , and \mathbf{H} is a matrix of eigenvectors. The eigensystem can be used to solve for deviations from the particular solution,

$$\mathbf{x}(t) = \mathbf{H} e^{\boldsymbol{\Lambda} t} \mathbf{c}, \quad (11)$$

where \mathbf{c} is a vector of constants. Given this particular solution, we get the following general solution,

$$\mathbf{y}(t) = \mathbf{H} e^{\boldsymbol{\Lambda} t} \mathbf{c} + \mathbf{y}^*(t), \quad (12)$$

⁶A convenient property of a log-linear system, like the one in Table 1, is that the linearization automatically transforms it from a non-autonomous system to an autonomous system. Further, see Gandolfo [5] and Kirkpatrick [9] for a discussion of the limitations and possibilities of the eigenvalue analysis of continuous time econometric models.

where $y^*(t)$ represents a particular solution.

In the following the long-run steady state solution of the model is derived. For the exogenous variables we set the following initial levels and growth rates:

$$\begin{aligned} y_f &= y_f^* e^{\lambda_1 t}, & P_f &= P_f^* e^{\lambda_2 t}, & P_i &= P_i^* e^{\lambda_3 t}, \\ R_f &= R_f^* e^{\lambda_4 t} = R_f^*, & SD_M &= SD_M^*, & SD_G &= SD_G^*, \\ SD_v &= SD_v^*, & SD &= SD^*, \end{aligned}$$

where the growth rate of the foreign interest rate is set to zero, $\lambda_4 = 0$. For the endogenous variables we have:

$$\begin{aligned} c &= c^* e^{p_1 t}, & x &= x^* e^{p_2 t}, & i &= i^* e^{p_3 t}, \\ y_d &= y_d^* e^{p_4 t}, & P_d &= P_d^* e^{p_5 t}, & P_x &= P_x^* e^{p_6 t}, \\ R_d &= R_d^* e^{p_7 t} = R_d^*, & T &= T^* e^{p_8 t}, & GE &= GE^* e^{p_9 t}, \\ A &= A^* e^{p_{10} t}, & NFA &= NFA^* e^{p_{11} t}, & RFX &= RFX^* e^{p_{12} t}, \\ B &= B^* e^{p_{13} t}, & EF &= EF^* e^{p_{14} t} = EF^*, & M &= M^* e^{p_{15} t}, \\ GD &= GD^* e^{p_{16} t}, & v &= v^* e^{p_{17} t} \text{ and,} & ES &= ES^* e^{p_{18} t} = ES^*. \end{aligned}$$

Substitution of these expressions into the model leads to a system with the following unknown parameters: the growth rates ρ and the initial values of the endogenous variables y^* , as well as the structural parameters of the model; $\alpha, \beta, \gamma, \nu$. The complete model is shown in Appendix 1. The system can be decomposed into two sets of equations. The first set including only factors that depend on time, and a second set consisting of the remaining variables. The first set of factors lead to the following system,

$$\alpha_1(\beta_1\rho_4 - \rho_1) - \alpha_2[\beta_{22}(\rho_5 + \rho_4) - \rho_{15}] = 0 \quad (13:1)$$

$$\alpha_3[\beta_3(\lambda_2 - \rho_6) + \beta_4\lambda_1 - \rho_2] = 0 \quad (13:2)$$

$$\alpha_4[\beta_5(\rho_5 - \lambda_3) + \beta_6\rho_4 - \rho_3] + \alpha_5(\rho_4 - \rho_{17}) = 0 \quad (13:3)$$

$$\alpha_6(\beta_7\lambda_1 - \rho_4) + \alpha_7(\rho_4 - \rho_{17}) = 0 \quad (13:4)$$

$$\alpha_8(\beta_8\lambda_2 - \rho_5) = 0 \quad (13:5)$$

$$\alpha_9(\beta_9\lambda_2 - \rho_6) = 0 \quad (13:6)$$

$$0 = 0 \quad (13:7)$$

$$\alpha_{11}[\beta_{10}(\rho_5 + \rho_4) - \rho_8] = 0 \quad (13:8)$$

$$\alpha_{12}[\beta_{11}(\rho_5 + \rho_4) - \rho_9] = 0 \quad (13:9)$$

$$\alpha_{13}[\beta_{22}(\rho_5 + \rho_4) - \rho_{15}] = 0 \quad (13:10)$$

$$\alpha_{14}[\beta_{14}(\rho_5 + \rho_4) - \beta_{15}(\lambda_1 + \lambda_2) - \rho_{11}] = 0 \quad (13:11)$$

$$\alpha_{15}\alpha_{16}(\beta_{16}\rho_{16} - \rho_{12}) = 0 \quad (13:12)$$

$$\alpha_{18}\alpha_{19}[\beta_{17}\rho_{16} - \rho_{13}] - \alpha_{20}[\beta_{22}(\rho_5 + \rho_4) - \rho_{15}] = 0 \quad (13:13)$$

$$\alpha_{21}\beta_{19}(\rho_5 - \lambda_2) = 0 \quad (13:14)$$

$$\rho_{15} = \rho_{16} = \rho_{13} = \rho_{10} = \rho_{12} \quad (13:15)$$

$$\rho_{16} = \rho_9 = \rho_8 \quad (13:16)$$

$$\rho_{17} = \rho_4 = \rho_1 = \rho_3 = \rho_2 \quad (13:17)$$

$$(\rho_6 + \rho_3) = (\lambda_3 + \rho_2) = \rho_{11} = \rho_{12}. \quad (13:18)$$

The second set of factors describes how the initial values are related to the parameters of the system. In the long run, the system is driven by the growths rates of the exogenous variables: the foreign income (λ_1), the foreign price level

(λ_2) and, the import price level (λ_3)⁷. Given the growth rates of the exogenous variables and parameter values, the growth rates of all endogenous variables can be solved from the first set of functions as follows.

The income identity (13:17) shows that all real variables will grow at the same rate in the steady state. The growth of the real variables can be solved from the domestic income equation (13:4). Since the income identity tells us that the growth of income equals the growth in stocks ($\rho_4 = \rho_{17}$), we get from Equation 13:4 that domestic income follows foreign income, adjusted for the elasticity β_7 . Thus, all real variables included in Identity 13:17 must grow at the rate given by $\beta_7 \lambda_1$.

The equation for the domestic price level shows that it grows at the rate $\beta_8 \lambda_2$. From the expected foreign exchange rate equation (13:14), however, we have that domestic prices grow with foreign prices, $\rho_5 = \lambda_2$. For domestic prices this implies that purchasing power parity holds in the long run, such that $\beta_8 = 1.0$.

From the equation for bank advances we get the long-run solution of the money market, $\rho_{15} = \beta_{22}(\lambda_2 + \beta_7 \lambda_1)$. The solution predicts that bank advances clear the money market in the long run. Moreover, the money supply (13:15) and the government debt (13:16) identities show that all financial variables should grow at this rate. If the growth of money is substituted into the equations for taxes (13:8), government expenditure (13:9) and growth in advances (13:10), we get that the long-run elasticities with respect to nominal income should be identical in all three equations, $\beta_{10} = \beta_{11} = \beta_{22}$.

⁷An alternative solution is to assume that foreign prices and import prices grow at the same steady state rate. This solution, however, leads to quite restrictive restrictions on the parameters, which are not likely to hold during the relatively short sample period of the model.

Given that the money market clears in the steady state solution, it follows that the income elasticity in the consumption function equals unity, $\beta_1 = 1.0$. Finally, since all financial assets should grow at the same rate we also get that the elasticities in the equations for bank advances and net foreign assets of the government sector should equal unity, $\beta_{16} = \beta_{17} = 1.0$. These restrictions are summarized in Table 5.

The remaining restrictions originate from the balance of payments identity. A stable current account requires $(\rho_6 + \rho_3) = (\lambda_3 + \rho_2)$. From equation (13:6) export prices grow by $\rho_6 = \beta_9 \lambda_2$. This result, together with the solution for the growth rates of exports and imports, show that the elasticity in the export price equation must offset different growth rates in imports and foreign price levels, $\beta_9 \lambda_2 = \lambda_3$.

Equilibrium in the balance of payments requires that the current account equal the capital account. Setting identical growth rates for export and import prices, we get from combining the balance of payments identity with the equations for RFX , that

$$\beta_8 \lambda_2 + \beta_7 \lambda_1 = \beta_{22}(\lambda_2 + \beta_7 \lambda_1).$$

Finally from the net foreign assets equation follows the following restriction,

$$\beta_{22}(\lambda_2 + \beta_7 \lambda_1) = \beta_{14}(\lambda_2 + \beta_7 \lambda_1) - \beta_{15}(\lambda_2 + \lambda_1),$$

which relates the nominal growth in net foreign assets with nominal growth in domestic and foreign incomes.

TABLE 4 ABOUT HERE.

TABLE 5 ABOUT HERE.

For given growth rates, parameters and initial states of the exogenous variables, the steady state initial levels of the endogenous variables are solved from the equations in Appendix 2. This solution implies further restrictions on the parameters, which are not imposed on the model. Since most of the variables are used in the linearization around the steady state growth paths in the identities, this results in extremely complex expressions, involving almost every parameter in the model.

3. ESTIMATION.

The model is estimated from a sample of monthly observations for the period 1982:6 to 1988:6. The estimation of the parameters is based on an approximation to the discrete time analogue of the system, see Appendix 2.⁸ To simplify estimation, the identities in the model are linearized around the sample means of the variables. The estimated parameters are then put into the original nonlinear model and utilized to linearize the system around its steady state growth paths. It is the eigenvalues of the latter model that are used to analyse the dynamics of the system.

Estimated adjustment parameters (α parameters) are presented in Table 6.

⁸The estimation of parameters and eigenvalues are done with the computer programs RESIMUL and CONTINES, written by Clifford Wymer.

and long-run elasticities (β parameters) in Table 7. The mean time lag, for each endogenous variable estimated with a first order equation, is given by $(1/\alpha)$. It represents the time needed to close 63% of the gap between the long-run equilibrium and the actual value. The mean lag is calculated under the assumption that the excess demand expressions for money and inventories included in the equations are zero. There is no corresponding interpretation of the α parameters estimated in the second order equations.

TABLE 6 ABOUT HERE.

Roughly, three groups of adjustment speeds can be distinguished: a first group consisting of variables adjusting within a month, a middle group of variables adjusting within three or four months, and, finally, a group adjusting over several years. In the first group we find government expenditure and tax income, exports and the expected exchange rate. These variables have adjustment speeds close to one week. They are closely followed by private consumption, imports, income and, the growth in bank advances which adjust within one month. These estimates suggest speeds of adjustment that are almost instantaneous.

In the middle group, we find the domestic interest rate and the export price level, adjusting within one or two quarters. The last group contains net foreign assets and the domestic price level. The mean time lags associated with these variables are around one year. Due to the specification as second order difference equations, it is not possible to calculate similar adjustment speeds for the holdings of government bonds and the net foreign assets held by the public sector. The I(2) characteristics, however, suggest relatively slow speeds of

adjustment.

The main difference between the estimates of this model and those of other continuous time models is that most of the adjustment speeds are faster. The relations between these speeds, however, are similar to those found in most other continuous time models. Real markets generally adjust faster than prices and interest rates, which in turn adjust slower than holdings of financial stocks. Demand for exports is among the fastest, while net foreign assets are among the slowest variables.

For all quantity markets the adjustment speed is less than 30 days. Take private consumption as an example, when the money market is in equilibrium, $M^* = M$, households adjust 67% of their consumption plans within a month following a change in income. The high adjustment speeds are likely to be the result of a lack of capacity constraints in the model. The sample begins just at the bottom of a recession period and the international economy is growing quite steadily throughout the rest of the observation period. Further the large devaluations in the early 1980s can be assumed to have boosted the Swedish economy. At the end of the sample the Swedish economy shows clear signs of overheating, with low unemployment and high inflation. Under these circumstances, the exclusion of an investment equation and a labour market are likely explanations behind the rapid adjustment speeds.

The fast adjustment of taxes and government expenditure might reflect a high efficiency in the fiscal and the transfer systems. For each month we have that the flow of taxes and government expenditure can be written as a function of the flow of income during the same month.

Adjustment costs and foreign exchange restrictions can explain the behaviour of the financial markets. Also, the slow adjustment in net foreign

assets (*NFA*) is also conditional on the other items in the balance of payments. To have equilibrium in balance of payments, the adjustment of *NFA* must correspond to the adjustment of both the current account and holdings of net foreign assets by the government.

The estimated β values, in Table 7, have the expected signs and are often close to their expected long-run values. Three β parameters were restricted to unity during estimation, the income elasticities in the imports equation, β_6 , and in the net foreign asset equation, β_{14} and β_{15} . We comment on the coefficients relevant for the steady state solution in the next section. The estimated (aggregated) constant terms, and the residual errors are presented in Table 8 and Table 9.

TABLE 7 ABOUT HERE.

TABLE 8 ABOUT HERE.

TABLE 9 ABOUT HERE.

The estimated Carter–Nagar system R_w^2 is 0.57.⁹ The system R_w^2 can be used to test two hypotheses about the model. The first is that the model is not consistent with the data. Under the null hypothesis that $R_w^2 = 0$, this test follows a chi square distribution with 54 degrees of freedom. The test statistic is 1338.7, which is above the critical value 74.5. The null hypothesis that the model is not consistent with the data is therefore rejected. The second hypothesis is that the over-identifying restrictions of the model are consistent with the data. The chi-square distributed test statistic is 1465.3, with a critical value of 454.0 for

⁹The Carter and Nagar [4] R_w^2 has the same interpretation as the usual R^2 . It shows what proportion of the variation in the endogenous variables is accounted for by the variation in the systematic part of the model.

408 degrees of freedom it leads to a rejection of the hypothesis. This is a common result for limited samples, that incorporate large amounts of *a priori* information. While the outcome of the test reduces the strength of the analysis, remember that it is an asymptotic test which, in general, is not valid for small samples.

3. THE ESTIMATED STEADY STATE SOLUTION.

The necessary conditions for a steady state solution were derived in the second section. The question in this section is whether the estimated parameters of the system fulfill the conditions of the steady state solution derived in Section 2. Given confidence intervals of two times the estimated standard errors, most parameters are in line with the steady state restrictions in Table 5. Two estimates, however, are outside the interval. First, the nominal income elasticities in the equations for money demand, government expenditure and tax revenue should be equal ($\beta_{22} = \beta_{10} = \beta_{11}$). While the point estimates of β_{22} and β_{10} are around 0.5, the estimate of β_{11} is 1.2, and their confidence intervals are not overlapping. Second, the estimate of the elasticity in the equation for non-bank holdings of government bonds (β_{17}) is significantly different from unity.

Deviations from the steady state are of interest because they identify potential sources for a lack of credibility of the foreign exchange rate system. The estimate of the elasticity in the supply of bonds equation (β_{17}) is connected to the elasticity with respect to nominal income in money demand (β_{22}). The latter is around 0.5, meaning that a unit increase in nominal income leads to a

proportional lower demand for money balances, and implying an elasticity above unity in the demand for bonds. Since an increase in income leads to a reduction of government debt, the supply elasticity of bonds must be higher than unity to satisfy demand.

The sample period starts when government debt peaked in relation to GDP. During the sample period the government reduces expenditure in relation to GDP so that the budget becomes positive in 1988. This is inconsistent with a long-run steady state equilibrium. On the other hand we cannot conclude that these deviations would generate observed devaluation expectations on their own, since they represent adjustment towards long-run economic stability. Conditionally on the stabilization of the government budget other factors will determine the stability of the economy. The following eigenvalue analysis is therefore conditional on the assumption that the budget policy is stabilizing in the long-run. The estimated model can then be viewed as having a steady state solution, which is valid during and for some time after the sample period.

5. LINEARIZATION OF THE MODEL.

For the purpose of linearizing the model around its steady state, the following new variables are defined,

$$x_1 = \log (c / c^* e^{p_1 t}),$$

$$x_2 = \log (x / x^* e^{p_2 t}),$$

$$x_3 = \log (i / i^* e^{p_3 t}),$$

$$x_4 = \log (y_d / y_d^* e^{p_4 t}),$$

$$\begin{aligned}
x_5 &= \log (P_d / P_d^* e^{p_5 t}), \\
x_6 &= \log (P_x / P_x^* e^{p_6 t}), \\
x_7 &= R_d - R_d^*, \\
x_8 &= \log (T / T^* e^{p_8 t}), \\
x_9 &= \log (GE / GE^* e^{p_9 t}), \\
x_{10} &= a - a^*, \\
x_{11} &= \log (NFA / NFA^* e^{p_{11} t}), \\
x_{12} &= rfx - rfx^*, \\
x_{13} &= b - b^*, \\
x_{14} &= \log (EF / EF^*), \\
x_{15} &= \log (M / M^* e^{p_{15} t}), \\
x_{16} &= \log (GD / GD^* e^{p_{16} t}), \\
x_{17} &= \log (v / v^* e^{p_{17} t}), \\
x_{18} &= \log (ES / ES^*), \\
x_{19} &= \log (B / B^* e^{p_{13} t}), \\
x_{20} &= \log (RFX / RFX^* e^{p_{12} t}), \\
x_{21} &= \log (A / A^* e^{p_{10} t}).
\end{aligned}$$

These variables are used to transform the original model into an autonomous system. Each equation in the original system is satisfied by its steady state solution. Using the x_i variables defined above, a linear system in terms of deviations around the steady state is found by subtracting the steady state solution in Appendix 1 from the model. Performing these subtractions, and linearizing when necessary¹⁰, results in,

¹⁰The linearization of the identities is explained in Appendix 3.

$$\begin{aligned} Dx_1 = & \alpha_1 (\beta_1 x_4 - x_1) - (\alpha_1 \beta_2 + \alpha_2 \beta_{23}) x_7 \\ & - \alpha_2 (\beta_{22} x_5 + \beta_{22} x_4 - x_{15}). \end{aligned} \quad (14:1)$$

$$Dx_2 = \alpha_3 \beta_3 x_{18} - \alpha_3 \beta_3 x_6 - \alpha_3 x_2 \quad (14:2)$$

$$\begin{aligned} Dx_3 = & \alpha_4 \beta_5 x_5 - \alpha_4 \beta_5 x_{18} + \alpha_4 \beta_6 x_4 - \alpha_4 x_3 + \alpha_5 x_4 \\ & - \alpha_5 x_{17} \end{aligned} \quad (14:3)$$

$$Dx_4 = -\alpha_7 x_{17} - (\alpha_6 - \alpha_7) x_4 \quad (14:4)$$

$$Dx_5 = \alpha_8 \beta_8 x_{18} - \alpha_8 x_5 \quad (14:5)$$

$$Dx_6 = \alpha_9 \beta_9 x_{18} - \alpha_9 x_6 \quad (14:6)$$

$$Dx_7 = \alpha_{10} x_{14} - \alpha_{10} x_{18} - \alpha_{10} x_7 \quad (14:7)$$

$$Dx_8 = \alpha_{11} \beta_{10} x_5 + \alpha_{11} \beta_{10} x_4 - \alpha_{11} x_8 \quad (14:8)$$

$$Dx_9 = \alpha_{12} \beta_{11} x_5 + \alpha_{12} \beta_{11} x_4 - \alpha_{12} x_9 \quad (14:9)$$

$$\begin{aligned} Dx_{10} = & \alpha_{13} \beta_{22} x_5 + \alpha_{13} \beta_{22} x_4 - \alpha_{13} \beta_{23} x_7 - \alpha_{13} x_{15} \\ & - \alpha_{13} x_{10} \end{aligned} \quad (14:10)$$

$$\begin{aligned} Dx_{11} = & \alpha_{14} \beta_{12} x_7 - \alpha_{14} \beta_{12} x_{14} + (\alpha_{14} \beta_{12} - \alpha_{14} \beta_{13} - \alpha_{14} \beta_{15}) x_{18} \\ & + \alpha_{14} \beta_{14} x_5 + \alpha_{14} \beta_{14} x_4 \end{aligned} \quad (14:11)$$

$$\begin{aligned} Dx_{12} = & \alpha_{15} \alpha_{16} \beta_{16} x_{16} - \alpha_{15} \alpha_{16} x_{20} - \alpha_{15} x_{12} \\ & - \alpha_{17} x_{18} \end{aligned} \quad (14:12)$$

$$\begin{aligned} Dx_{13} = & \alpha_{18} \alpha_{19} \beta_{17} x_{16} + \alpha_{18} \alpha_{19} \beta_{18} x_{18} - \alpha_{18} x_{13} \\ & - \alpha_{18} \alpha_{19} x_{19} - \alpha_{20} \beta_{22} x_5 - \alpha_{20} \beta_{22} x_4 + \alpha_{20} \beta_{23} x_7 \\ & + \alpha_{20} x_{15} \end{aligned} \quad (14:13)$$

$$\begin{aligned} Dx_{14} = & \alpha_{21} \beta_{19} x_5 + \alpha_{21} \beta_{20} x_7 + \alpha_{21} \beta_{21} x_{18} \\ & - \alpha_{21} x_{14} \end{aligned} \quad (14:14)$$

$$\begin{aligned} x_{18} = & -P_1^* i^* x_3 + \frac{P_x^* x^*}{ES^* P_1^* i^*} (x_6 + x_2) \\ & + \frac{NFA^*}{ES^* P_1^* i^*} (Dx_{11} + \rho_{11} x_{11}) \\ & + \frac{RFX^*}{ES^* P_1^* i^*} (Dx_{12} + \rho_{12} x_{12}) \end{aligned} \quad (14:18)$$

$$Dx_{19} = x_{13} \quad (14:19)$$

$$Dx_{20} = x_{12} \quad (14:20)$$

$$Dx_{21} = x_{10} \quad (14:21)$$

Equations (14:1) to (14:21) define the system in terms of deviations from its steady state solution. Solutions for the initial conditions can be found, given estimates of the parameters as well as initial conditions and growth rates of the exogenous variables. Apparently the estimated parameters, especially the constant terms in Table 8, do not lead to a convincing solution of the initial state. For instance, they imply an initial GDP level that is smaller than the initial level of exports. The reasons behind this are probably the limited sample period and the artificial scales of some variables, like the foreign income and the stocks of financial variables that are accumulated from starting values which are best described as informed guesses. This is not a serious shortcoming because what is important for the linearization are the relative sizes of the variables, not their levels.

The initial states used in the linearization process are set as follows, inventories 85000 millions of Swedish kronor (MSEK), money 200000 MSEK, government debt 240000 MSEK, and real domestic income 65000 MSEK on a monthly basis. All figures correspond to levels at the beginning of the 1980s. The relation between income, consumption, exports and imports is determined using averages of yearly data from 1950 to 1990. Government expenditure is set to 60% of income, taxes to 60% of income minus the steady state growth of government debt of 2% on a yearly level. Bonds, net foreign assets and net reserves are determined from sample means of the variables. Finally, bank advances are determined residually.

6. STABILITY AND SENSITIVITY ANALYSIS.

The eigenvalues of the system (14:1) – (14:21) show whether the steady state is stable. In Table 10, there is one positive real root that suggests that the system is not locally stable. Saddle point solutions are not bad or good features of macroeconomic models, since there is no *a priori* information that says that the economy should be stable. A shock to the system could cause it to explode, unless agents have rational expectations and follow the unique path that leads to equilibrium.¹¹ Alternatively, some parameter(s) values, representing the behaviour of private agents or the government and the central bank, must change to put the economy back on a stable path.

TABLE 9 ABOUT HERE.

The positive eigenvalue in Table 10 is small and associated with a large standard error. We conclude, therefore, that it is not significantly different from negative and that the model has a stable solution. Moreover, there are four complex roots implying that adjustment in some parts of the system are associated with cyclical behaviour. Since all have negative real parts these cycles are stable. The dampening periods range between 2 weeks and 25 years. The amplitudes of the cycles associated with the complex roots vary between 9 months and 4 years.

Further insights into the dynamics of the model can be gained by calculating the sensitivity of the eigenvalues with respect to small changes in the

¹¹Rational expectation models generally lead to saddle point solutions. see Begg [1] and Buiter [3].

parameters of the system. From the eigensystem of the model we obtain partial derivatives of the eigenvalues with respect to the estimated parameters of the model, $(\delta\mu_j/\delta\theta_i)$. These derivatives show what happens to the stability of the model following a small change in a parameter value. The complete matrix consists of 21×74 partial derivatives. Most are zero, or so small that they can be neglected. By selecting those that could possibly affect the roots, the number decreases drastically. In the tables below we have, with some exceptions, picked out those derivatives that have an absolute value of at least 50% of the eigenvalue.

Table 10 ABOUT HERE.

Two groups of parameters affect the stability of the system. The first, shown in Table 11 – Panel A, consists of adjustment parameters associated with the effects of inventories on production (α_7) the domestic price level (α_8), the export price level (α_9), and bank advances (α_{16}). The second group, Panel B, is the set of parameters associated with the foreign exchange markets, the domestic interest rate (α_{10}), the net foreign assets held by the private sector (α_{14}), and the net foreign reserves held by public sector (α_{13}). Besides these parameters we have the elasticities in the equation for the expected foreign exchange rate index, $(\beta_{19}, \beta_{20}, \beta_{21})$.

In the first group all derivatives are negative. Slight decreases in the adjustment speeds of these variables (\equiv the value of α increases) have stabilizing effects on the model, in the sense that the eigenvalues get smaller. The largest effects are associated with the adjustment of domestic and export price levels. Attempts to delay the adjustment by price controls would, *ceteris paribus*, have

destabilizing effects on the economy.

In the second group, the largest figures are associated with the speed of adjustment in the net foreign asset equation, (α_{14}). A slight increase in the adjustment speed would be stabilizing on the fifth root. On the other hand, the effects would be destabilizing on the twelfth, the fifteenth and to some extent also on the seventeenth root. The cycles associated with the last two roots would increase as well. Within the framework of our model a balance of payments crises is described as a situation where the adjustment speed in the foreign assets markets goes to infinity ($\alpha_{14} \rightarrow \infty$). This situation is obviously destabilizing to the model, since some derivatives are negative. However, as long as the change in α_{14} is relatively small, the effects are more stabilizing than destabilizing, judging from a comparison of the sizes of the derivatives. In the next section we will try to quantify these effects.

The same derivatives associated with the net foreign reserves held by the government sector are shown as well. The idea is to see if changes in the adjustment of ΔNFA could be offset by changes in the intervention policy. However, the effects of changes in the adjustment ΔRFX are not always identical or opposite to those of ΔNFA . The largest impact of changes in α_{16} is on the fifth root, but there is no effect on the twelfth one. The remaining two derivatives are too small to be important. Thus, based on a *ceteris paribus* reasoning, there can be no systematic stabilization in the sense that the authorities, by mimicking the behaviour of private net foreign assets, could stabilize the system.

The sign of the first root is crucial for the stability of the model. The factors that affect this root are, the adjustment speeds of domestic prices and interest rates and the three elasticities in the expected exchange equation. That the

derivative with respect to the adjustment of the domestic interest rate affects the first root is interesting, since we can assume that it reflects open market operations by the Riksbank. If interventions create gaps between the domestic and the foreign rate (α_{10} gets smaller), or preventing gaps from being closed too rapidly, this policy is clearly stabilizing.

The difference between domestic and foreign rates of interest plays a crucial role for stability in other parts of the model. In the expected exchange rate equation, a small increase in the elasticity with respect to the interest rate gap is destabilizing, since the forward premium would constantly predict depreciations above the expectations reflected in the interest rate differential. This can be explained by the fact that the basic motive for interventions is that authorities hold better views of the long run than other agents do. However, if expectations of the long run held by private agents and the authorities differs continuously their behavior is incompatible with a stable steady state solution.

7. BIFURCATION POINTS.

So far the analysis has dealt more with the signs of the derivatives than their sizes. It remains to investigate how much a parameter must change to have a quantitative effect on the dynamics of the model. The value where a parameter determines whether a system is stable or unstable is called a bifurcation point. Following Gandolfo and Padoan [6] we can approximately calculate these values by starting from the derivative of the j :th eigenvalue (μ_j) with respect to i :th parameter (θ_i), its derivative becomes $d\mu_j = (\delta\mu_j/\delta\theta_i) d\theta_i$. Setting $\mu_j + d\mu_j = 0$, for a non-zero eigenvalue μ_j , we solve for the change in θ_i ,

$$d\theta_i = -\mu_j / (\delta\mu_j / \delta\theta_i), \quad (15)$$

where $d\theta_i$ is the change in parameter θ_i that causes the sign of the eigenvalue to change. The bifurcation value (θ_i^{bi}) is then approximately given by $\theta_i^{bi} = \theta_i + d\theta_i$. Given these values we can ask whether the estimated parameters are significantly different. Assuming an asymptotically normal distribution of the parameters, and selecting a 5% risk level, the resulting asymptotic confidence interval is ± 1.96 times the standard errors.

Following Gandolfo and Padoan [6] we say that the system is structurally unstable if the bifurcation value of parameter θ_i lies within the confidence interval of that parameter,

$$\theta_i - 1.96\hat{\sigma}_i < \theta_i - \mu_j / (\delta\mu_j / \delta\theta_i) < \theta_i + 1.96\hat{\sigma}_i, \quad (16)$$

where $\hat{\sigma}_i$ is the estimated standard error of parameter θ_i . If the bifurcation value falls outside the asymptotic confidence interval we say that the model is structurally stable, that is if,

$$\begin{aligned} \theta_i - \mu_j / (\delta\mu_j / \delta\theta_i) &< \theta_i - 1.96\hat{\sigma}_i \\ \theta_i - \mu_j / (\delta\mu_j / \delta\theta_i) &> \theta_i + 1.96\hat{\sigma}_i. \end{aligned} \quad (17)$$

Expression (16) can be manipulated to a relative measure of how close the bifurcation value is to the confidence interval. Subtracting θ_i and taking the absolute value of (16) gives,

$$|\delta\mu_j/\delta\theta_i| > |\mu_j|/1.96\hat{\sigma}_i. \quad (18)$$

Multiplying both sides by $|\theta_i|/|\mu_j|$ leads to,

$$|\theta_i|/|\mu_j| |\delta\mu_j/\delta\theta_i| = |\eta_{ji}| > |\theta_i|/1.96\hat{\sigma}_i, \quad (19)$$

where η_{ji} is the elasticity of the j :th eigenvalue with respect to i :th parameter. It follows, since the absolute value of a significant parameter will be greater than 1.96 times its standard error, that the right hand side of (19) is greater than 1.0. Therefore, the elasticity $|\eta_{ji}|$ must be greater than unity for a confidence interval to span over parameter values that change the stability of the model.

TABLE 11 ABOUT HERE.

The calculated bifurcation points and the elasticities derived above are presented in Table 12 for the same parameters and eigenvalues as in Table 11. The first value in each cell is the elasticity, in absolute terms, of the j :th eigenvalue with respect to $\delta\mu_j/\delta\theta_i$, the second value is the change in the parameter value needed to make the eigenvalue zero ($d\theta_i$), the third value is the estimate ($\hat{\theta}_i$), and the last value is the bifurcation point. Asterisks indicate parameters which are critical for the stability of the model.

The results suggest that most of the estimated parameters would have to change substantially to change the dynamics of the model. The exceptions are the elasticities with respect to the interest rate differential, and the spot foreign exchange rate in the expected exchange equation. There are four values in Tables 12:a and 12:b which exceed their critical bifurcation points. They are

associated with the adjustment speeds of the domestic price level (α_8), the interest rate (α_{10}) and the last two elasticities in expected exchange rate equation (β_{20} and β_{21}).

The first root in Table 12 is positive but not significant. The third root is also critical. Since it is associated with an elasticity greater than one the structural stability of the model can be questioned. The confidence interval of the adjustment speed of the domestic price level (α_8) includes values that make the model unstable.

There are two other parameters that have elasticities close to unity: the adjustment speeds of export prices (α_9) and net foreign reserves held by the government and the public sector. It can also be seen that despite the relatively large value of the adjustment speed of net foreign assets (α_{14}) in Table 11, the second group, this estimate would have to change drastically to destabilize the system. The calculated bifurcation point associated with its effects on the twelfth root is 16 times higher than the estimate of α_{14} . In terms of mean time lags, this is equal to an increase in the adjustment speed from around 2 years to 1½ month. Judging from the size of the elasticities, however, the initial effect of a change in the adjustment speed of net foreign assets is stabilizing, since the strongest effect is associated with the negative derivative with respect to the third root. In this respect, our results diverge from those by Gandolfo and Padoan [7] who found that liberalization of capital flows would clearly have a destabilizing effect on the Italian economy.

8. SUMMARY AND CONCLUSIONS.

This paper analyses the dynamic adjustment of the Swedish economy during the 1980s. The aim is to identify factors that are critical for the adjustment towards a stable long-run solution, given a fixed policy and foreign exchange regime. The steady state solution of the model reveals inconsistencies in the long-run paths of the financial markets and the government debt. The problems originate from incompatible income elasticities in the equations for money demand, government expenditure and tax income. This result appears to reflect the attempt to balance the government budget during the sample period. Extended into the future they suggest that government debt as a share of GDP is not constant in the long run since expenditure would fall behind tax income. There is little reason to expect that stabilization of the budget would generate expectations of devaluations on its own. Reported expectations appear more likely to be generated by a combination of the budget policy and the adjustment of other markets in the model.

Thus, a closer examination of the eigenvalues of the model, conditionally on the balancing of the government debt, shows that stability is related to the adjustment speeds of prices and the interest rate, and the determination of the expected exchange rate. An economic interpretation of these estimates suggests that policy actions towards faster adjustment speeds of domestic and export price levels increase the stability of the economy. On the other hand, an increase in the adjustment of the domestic interest rate would be destabilizing. If the relatively slow adjustment of the domestic interest rate is viewed as the outcome of interventions of the Riksbank, this policy is stabilizing.

The estimated eigenvalues and their sensitivity to small changes in the

parameters of the model are more indicative than reliable estimates. However, the problems of learning about the long run, and in understanding how changes in policy parameters affect the long run, are not specific for this paper. The eigenvalue analyses represent a possible formalization of how agents with bounded rationality learn about future stochastic paths of the economy. The speculative attacks against the krona, which came and went by between 1990 and 1992, can be understood as the outcome of difficulties in learning the system's stable trajectory.

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APPENDIX 1. The complete steady state solution of the model.

$$\begin{aligned}
 \rho_1 = & \alpha_1 \log \gamma_1 - \alpha_2 \log \nu_1 + (\alpha_1 \beta_1 - \alpha_2 \beta_{22}) \log y_d^* - \alpha_2 \beta_{22} \log P_d^* \\
 & - (\alpha_1 \beta_2 - \alpha_2 \beta_{23}) R_d^* - \alpha_1 \log c^* + \alpha_2 \log M^* \\
 & + [\alpha_1(\beta_1 \rho_4 - \rho_1) - \alpha_2\{\beta_{22}(\rho_5 + \rho_4) - \rho_{15}\}]t
 \end{aligned} \tag{A1:1}$$

$$\begin{aligned}
 \rho_2 = & \alpha_3 \log \gamma_3 + \alpha_3 \beta_3 \log ES^* + \alpha_3 \beta_3 \log P_f^* \\
 & - \alpha_3 \beta_3 \log P_x^* + \alpha_3 \beta_4 \log y_f^* - \alpha_3 \log x^* \\
 & + (\alpha_3 \beta_3 \lambda_2 - \alpha_3 \beta_3 \rho_6 + \alpha_3 \beta_4 \lambda_1 - \alpha_3 \rho_2)t
 \end{aligned} \tag{A1:2}$$

$$\begin{aligned}
 \rho_3 = & \alpha_4 \log \gamma_3 + \alpha_5 \log \nu_2 + \alpha_4 \beta_5 \log P_d^* \\
 & + (\alpha_4 \beta_5 \rho_5 - \alpha_4 \beta_5 \lambda_3 + \alpha_4 \beta_6 \rho_4 - \alpha_4 \rho_3 + \alpha_5 \rho_4 - \alpha_5 \rho_{17})t \\
 & - \alpha_4 \beta_5 \log ES^* - \alpha_4 \beta_5 \log P_i^* + (\alpha_4 + \alpha_5) \log y_d^* \\
 & - \alpha_4 \log i^* - \alpha_5 \log v^*
 \end{aligned} \tag{A1:3}$$

$$\begin{aligned}
 \rho_4 = & \alpha_6 \log \gamma_4 + \alpha_7 \log \nu_3 + \alpha_6 \beta_7 \log y_f^* + (\alpha_6 + \alpha_7) \log y_d^* \\
 & - (\alpha_6 \rho_4 - \alpha_6 \beta_7 \lambda_1 - \alpha_7 \rho_4 + \alpha_7 \rho_{17})t \\
 & - \alpha_7 \log v^*
 \end{aligned} \tag{A1:4}$$

$$\begin{aligned}
 \rho_5 = & \alpha_8 \log \gamma_5 + \alpha_8 \beta_8 \log ES^* + \alpha_8 \beta_8 \log P_f^* \\
 & + (\alpha_8 \beta_8 \lambda_2 - \alpha_8 \rho_5)t - \alpha_8 \log P_d^*
 \end{aligned} \tag{A1:5}$$

$$\begin{aligned}
 \rho_6 = & \alpha_9 \log \gamma_6 + \alpha_9 \beta_9 \log ES^* \\
 & + (\alpha_9 \beta_9 \lambda_2 - \alpha_9 \rho_6)t + \alpha_9 \beta_9 \log P_f^* \\
 & + \alpha_9 \beta_9 \log P_i^* - \alpha_9 \log P_x^*
 \end{aligned} \tag{A1:6}$$

$$\begin{aligned}
0 = & \alpha_{10} \gamma_7 + \alpha_{10} R_f^* + \alpha_{10} \log EF^* - \alpha_{10} \log ES^* \\
& - \alpha_{10} R_d^*
\end{aligned} \tag{A1:7}$$

$$\begin{aligned}
\rho_8 = & \alpha_{11} \log \gamma_8 + \alpha_{11} \beta_{10} \log P_d^* + \alpha_{11} \beta_{10} \log y_d^* \\
& + [\alpha_{11} \beta_{10} \rho_4 + \alpha_{11} \beta_{10} \rho_5 - \alpha_{11} \rho_8] t \\
& + \alpha_{11} \log T^*
\end{aligned} \tag{A1:8}$$

$$\begin{aligned}
\rho_9 = & \alpha_{12} \log \gamma_9 + \alpha_{12} \beta_{11} \log P_d^* + \alpha_{12} \beta_{11} \log y_d^* \\
& + [\alpha_{12} \beta_{11} \rho_4 + \alpha_{12} \beta_{11} \rho_5 - \alpha_{12} \rho_9] t \\
& - \alpha_{12} \log GE^*
\end{aligned} \tag{A1:9}$$

$$\begin{aligned}
0 = & \alpha_{13} a^* + \alpha_{13} \log \gamma_{10} + \alpha_{13} \log \nu_1 + \alpha_{13} \beta_{22} \log P_d^* \\
& + (\alpha_{13} \beta_{22} \rho_5 + \alpha_{13} \beta_{22} \rho_4 - \alpha_{13} \rho_{15}) t + \alpha_{13} \beta_{22} \log y_d^* \\
& - \alpha_{13} \beta_{23} R_d^* - \alpha_{13} \log M^* - \alpha_{13} a^*
\end{aligned} \tag{A1:10}$$

$$\begin{aligned}
\rho_{11} = & \alpha_{14} \log \gamma_{11} + \alpha_{14} \beta_{12} R_d^* - \alpha_{14} \log \gamma_7 - \alpha_{14} \beta_{12} R_f^* \\
& - \alpha_{14} \beta_{12} EF^* + (\alpha_{14} \beta_{12} - \alpha_{14} \beta_{13} - \alpha_{14} \beta_{14}) \log ES^* \\
& + \alpha_{14} \beta_{13} ET^* + \alpha_{14} \beta_{14} \log P_d^* + \alpha_{14} \beta_{14} \log y_d^* \\
& + (\alpha_{14} \beta_{14} \rho_5 + \alpha_{14} \beta_{14} \rho_4 - \alpha_{14} \beta_{14} \lambda_1 - \alpha_{14} \beta_{14} \lambda_2 - \alpha_{14} \rho_{11}) t \\
& - \alpha_{14} \beta_{15} \log P_f^* - \alpha_{14} \beta_{15} \log y_f^* \\
& - \alpha_{14} \log NFA^*
\end{aligned} \tag{A1:11}$$

$$\begin{aligned}
0 = & \alpha_{15} \alpha_{16} \log \gamma_{12} + \alpha_{15} \alpha_{16} \beta_{16} \log GD^* - \alpha_{15} \alpha_{16} \log RFX^* \\
& - \alpha_{15} rfx^* + (\alpha_{15} \alpha_{16} \beta_{16} \rho_{16} - \alpha_{15} \alpha_{16} \rho_{12}) t \\
& + \alpha_{17} \log ET^* - \alpha_{17} \log ES^* + \alpha_{17} \beta_{24} DUM1^*
\end{aligned} \tag{A1:12}$$

$$\begin{aligned}
0 = & \alpha_{18}\alpha_{19} \log \gamma_{13} - \alpha_{20} \log \nu_1 + \alpha_{18}\alpha_{19}\beta_{17} \log GD^* \\
& + \alpha_{18}\alpha_{19}\beta_{18} \log ET^* - \alpha_{18}\alpha_{19}\beta_{18} \log ES^* - \alpha_{18}\alpha_{19} \log B^* \\
& + (\alpha_{18}\alpha_{19}\beta_{17} \rho_{16} - \alpha_{18}\alpha_{19} \rho_{13} - \alpha_{20}\beta_{22} \rho_5 - \alpha_{20}\beta_{22} \rho_4 + \alpha_{20} \rho_{15})t \\
& - \alpha_{18} b^* - \alpha_{20}\beta_{22} \log P_d^* - \alpha_{20}\beta_{22} \log y_d^* + \alpha_{20}\beta_{23} \log R_d^* \\
& + \alpha_{20} \log M^*
\end{aligned} \tag{A1:13}$$

$$\begin{aligned}
0 = & \alpha_{21} \log \gamma_{14} + \alpha_{21}\beta_{18} \log P_d^* - \alpha_{21}\beta_{18} \log ET^* - \alpha_{21}\beta_{18} \log P_f^* \\
& + (\alpha_{21}\beta_{18} \rho_5 - \alpha_{21}\beta_{18} \lambda_2)t + \alpha_{21}\beta_{19} R_d^* - \alpha_{21}\beta_{19} R_f^* \\
& + \alpha_{21}\beta_{20} \log ES^* - \alpha_{21} \log EF^*
\end{aligned} \tag{A1:14}$$

$$\begin{aligned}
\rho_{15}M^* e^{\rho_{15}t} = & \rho_{16}GD^* e^{\rho_{16}t} + \rho_{13}B^* e^{\rho_{13}t} + \rho_{10}A^* e^{\rho_{10}t} \\
& + \rho_{12}RFX^* e^{\rho_{12}t} + SD_M^*
\end{aligned} \tag{A1:15}$$

$$\rho_{16}GD^* e^{\rho_{16}t} = GE^* e^{\rho_9t} - T^* e^{\rho_8t} + SD_G^* \tag{A1:16}$$

$$\begin{aligned}
\rho_{17}v^* e^{\rho_{17}t} = & y_d^* e^{\rho_4t} - c^* e^{\rho_1t} - x^* e^{\rho_2t} \\
& + i^* e^{\rho_3t} + sd_v^*
\end{aligned} \tag{A1:17}$$

$$\begin{aligned}
P_x^* e^{\rho_6t} x^* e^{\rho_2t} - ES^* P_i^* e^{\lambda_3t} i^* e^{\rho_3t} + \rho_{11}NFA^* e^{\rho_{11}t} \\
+ \rho_{12}RFX^* e^{\rho_{12}t} + SDE^* = 0
\end{aligned} \tag{A1:18}$$

$$\rho_{13} = b^* \tag{A1:19}$$

$$\rho_{12} = rfx^* \tag{A1:20}$$

$$\rho_{10} = a^* \tag{A1:21}$$

APPENDIX 2. The Steady state solution for intitial values.

$$\begin{aligned}\log c^* &= \log \gamma_1 - (\alpha_2/\alpha_1)\log \nu_1 - (1/\alpha_1)\rho_1 + (\beta_1 - \alpha_2\beta_{22}/\alpha_1) \log y_d^* \\ &\quad - (\beta_2 - \alpha_2\beta_{23}/\alpha_1) R_d^* - \alpha_2\beta_{22}/\alpha_1 \log P_d^* \\ &\quad + \alpha_2/\alpha_1 \log M^*\end{aligned}\tag{A2:1}$$

$$\begin{aligned}\log x^* &= -\rho_2/\alpha_3 + \log \gamma_2 + \beta_3 \log ES^* + \beta_3 \log P_f^* \\ &\quad - \beta_3 \log P_x^* + \beta_4 \log y_f^*\end{aligned}\tag{A2:2}$$

$$\begin{aligned}\log i^* &= -\rho_3/\alpha_4 + \log \gamma_3 + (\alpha_5/\alpha_4) \log \nu_2 + \beta_5 \log P_d^* \\ &\quad - \beta_5 \log ES^* - \beta_5 \log P_i^* + (\beta_6 + \alpha_5/\alpha_4) \log y_d^* \\ &\quad + (\alpha_5/\alpha_4) \log v^*\end{aligned}\tag{A2:3}$$

$$\begin{aligned}\log y_d^* &= [\alpha_6 \log \gamma_4 - \rho_4 - \alpha_7 \log \nu_2]/(\alpha_6 - \alpha_7) \\ &\quad + [\alpha_6\beta_7/(\alpha_6 - \alpha_7)]\log y_f^* \\ &\quad - [\alpha_7/(\alpha_6 - \alpha_7)] \log v^*\end{aligned}\tag{A2:4}$$

$$\begin{aligned}\log P_d^* &= -\rho_5/\alpha_8 + \log \gamma_5 + \beta_8 \log ES^* \\ &\quad + \beta_8 \log P_f^*\end{aligned}\tag{A2:5}$$

$$\begin{aligned}\log P_x^* &= -\rho_6/\alpha_9 + \log \gamma_6 + \beta_9 \log ES^* \\ &\quad + \beta_9 \log P_f^*\end{aligned}\tag{A2:6}$$

$$R_d^* = \gamma_7 + R_f^* + \log EF^* - \log ES^*\tag{A2:7}$$

$$\begin{aligned}\log T^* &= -\rho_8/\alpha_{11} + \log \gamma_8 + \beta_{10} \log P_d^* \\ &\quad + \beta_{10} \log y_d^*\end{aligned}\tag{A2:8}$$

$$\begin{aligned}\log GE^* &= -\rho_9/\alpha_{12} + \log \gamma_9 + \beta_{11} \log P_d^* \\ &\quad + \beta_{11} \log y_d^*\end{aligned}\tag{A2:9}$$

$$\begin{aligned}\log \gamma_{10} + \beta_{22} \log P_d^* + \beta_{22} \log y_d^* - \log M^* \\ - \beta_{23} \log R_d^* = 0\end{aligned}\tag{A2:10}$$

$$\begin{aligned}
\log NFA^* &= -(\rho_{11}/\alpha_{14}) + \log \gamma_{11} \\
&+ \beta_{12} (R_d^* - \gamma_7 - R_f^* - \log EF^*) + \beta_{13} \log ET^* \\
&+ (\beta_{12} - \beta_{13} - \beta_{15}) \log ES^* + \beta_{14} (\log P_d^* + \log y_d^*) \\
&- \beta_{15} (\log P_f^* - \log y_f^*)
\end{aligned} \tag{A2:11}$$

$$\begin{aligned}
\log RFX^* &= \log \gamma_{12} + \beta_{16} \log GD^* - (1/\alpha_{16}) \rho_{12} \\
&- (\alpha_{17}/\alpha_{15}\alpha_{16}) \log ET^* + (\alpha_{17}/\alpha_{15}\alpha_{16}) \log ES^* \\
&+ (\alpha_{17}\beta_{24}/\alpha_{15}\alpha_{16}) DUM1^* - (\alpha_{15} + 1) rfx^*
\end{aligned} \tag{A2:12}$$

$$\begin{aligned}
\log B^* &= \log \gamma_{13} - \alpha_{20} \log \nu_1 + \beta_{17} \log GD^* \\
&- [(\alpha_{18} + 1)/(\alpha_{18}\alpha_{19})] b + \beta_{18} \log ET^* \\
&- \beta_{18} \log ES^* - \alpha_{20}\beta_{22} \log P^* - \alpha_{23}\beta_{22} \log y_d^* \\
&+ \alpha_{20}\beta_{23} R_d^* + \alpha_{20} \log M^*
\end{aligned} \tag{A2:13}$$

$$\begin{aligned}
\log EF^* &= \log \lambda_{14} + \beta_{19} \log P_d^* - \beta_{19} \log ET^* - \beta_{19} \log P_f^* \\
&+ \beta_{20} R_d^* - \beta_{20} R_f^* + \beta_{21} \log ES^*
\end{aligned} \tag{A2:14}$$

$$M^* = GD^* - B^* + A^* - RFX^* + SDM^* \tag{A2:15}$$

$$\rho_{16}GD^* = GE^* - T^* + SDG^* \tag{A2:16}$$

$$\rho_{17}v^* = y_d^* - c^* - x^* + i^* + sd_v^* \tag{A2:17}$$

$$\begin{aligned}
P_x^* x^* - ES^* P_i^* i^* + \rho_{11}NFA^* + \rho_{12}RFX^* \\
+ SDE^* = 0
\end{aligned} \tag{A2:18}$$

$$\rho_{13} = b^* \tag{A2:19}$$

$$\rho_{12} = rfx^* \tag{A2:20}$$

$$\rho_{10} = a^*. \tag{A2:21}$$

APPENDIX 3. Estimation of continuous time econometric models.

The original model can be written as a system of stochastic first order differential equations,

$$Dy(t) = A y(t) + B z(t) + u(t), \quad (A3:1)$$

where D denotes the differential operator with respect to time. A and B are matrices of parameters, $y(t)$ a vector of endogenous, $z(t)$ a vector of exogenous variables, and $u(t)$ represents a vector of white noise innovations. The model is approximated by the following discrete time system,

$$\Delta y_t = A M y_t + B M z_t + e_t, \quad (A3:2)$$

where $\Delta x_t = x_t - x_{t-1}$, $Mx_t = \frac{1}{2}(x_t + x_{t-1})$, and e_t is a vector of residuals which are approximately $e_t \sim N(0, \sigma^2)$. The residuals will be autocorrelated as a consequence of the approximation.

Since the model contains flow variables which cannot be observed at a point in time, it must be integrated over the observation interval. This has two consequences. First, it leads to improper integrals over stock and price variables. If x_t is a generic stock variable it can be approximated by $x_t = \frac{1}{2}x_t + x_{t-1}$. Prices and interest rates can be approximated by means over the observation interval. Second, the integration introduces a moving average process in the residuals, which is approximately,

$$e_t \approx (1 + 0.268) \eta_t, \quad (A3:3)$$

where η_t is a vector of white noise residuals. From A3:3 the following filter can be constructed which has been used to pre-whiten the data,

$$\dot{x}_t = x_t - 0.268^1 x_{t-1} + 0.268^2 x_{t-2} - 0.268^3 x_{t-3}. \quad (A3:4)$$

APPENDIX 4. The Database

Capital letters indicate that the variable is measured in nominal terms, while small letters indicate real values. The subscripts d and f refer to domestic and foreign variables, respectively.

The following abbreviations are used in this section:

AM : Allmän månadsstatistik. Monthly Digest of Swedish Statistics, published by Statistics Sweden.

BB : Monatsberichten der Deutsche Bundesbank, Statistische Beihefte.

BNP: BNP/KVARTAL, published by Statistics Sweden.

IFS : International Financial Statistics, tapes and publications issued at various dates, by the International monetary fund.

KV : Kredit- och valutaöversikt, ("Credit and Currency Review") published by Sveriges Riksbank.

RB : series supplied directly by the Central Bank of Sweden (Riksbanken).

List of variables

- A Bank advances to non – bank public. The series is equal to the difference between "*Bank advances to non – bank public*" including "*Advances in foreign currency*" minus "*Advances to non – bank public in foreign currency*." Source: AM.

- B Non-bank holdings of government debt at nominal value. Calculated residually by subtracting other sectors holdings from the total amount of government debt.

- c* Private consumption, interpolated from quarterly data using monthly values of retail trade sales index. (See also the construction of y_d). Sources: BNP and AM.
- ES* Effective foreign exchange rate index. This is a geometric index of end-of-month spot foreign exchange rates, calculated with the same weights and currencies as the index used by the central bank of Sweden (Riksbanken). The index is trade weighted, and constructed with the currencies of Sweden's fifteen most important trading countries. Source: KV and IFS.
- EF* Expected foreign exchange rate, approximated with a three month effective forward foreign exchange rate index, calculated in the same way as *ES* above. Sources: KV, IFS and BB.
- ET* Target value of the exchange rate index used by the Riksbank. The target was set to 100 in August 1977, 110 in October 1981 and 132 in September 1982. The maximum variation around the target was set to $\pm 2.5\%$ in 1977. In June 1985 this was changed to $\pm 1.5\%$.
- GD* Government debt. Source: Riksgäldskontoret (The Treasury).
- GE* Government expenditure, including consumption, investments and transfers to other sectors. Source: AM.
- i* Imports of goods and services. Source: RB.
- igcy* Exogenous variables in the income identity. This variable includes investment of all sectors, government consumption, local government consumption and "correction" terms in the statistics. Source: BNP.
- M* Stock of money, M3. Source: RB.

- NFA_p Stock of net foreign financial assets held by the private sector. This series is generated by accumulating flows in the balance of payments around a starting value of 65 225 MSEK in December 1984. NFA_p includes all private flows recorded in the capital account, including errors and omissions but excluding direct investments. The series is defined as debt – liabilities, which means, that an increase in NFA_p leads an inflow of money. Source: RB.
- P_d Domestic price level. The consumer price index is used as a proxy. Source: AM.
- P_f Foreign price level. Consumer prices of Industrial Countries is used as a proxy variable. Source: IFS.
- P_i Import price index in foreign currency, calculated by dividing the nominal import price index in SEK with ES . Source: AM.
- P_x Export price index. Source: AM.
- R_d Domestic interest rate, three-month treasury bills. Monthly averages expressed as three-month values, annual percentage interest rates divided by 400. Source: KV.
- R_f Foreign interest rate, three-month Eurodollar rate in London. Monthly averages expressed as three-month values, see above. Sources: KM and KV.
- x Exports of goods and services. Source: RB.
- T Total nominal tax income by the government. Source: AM.
- RFX Net stock of foreign assets held by the public sector, defined as debt minus liabilities, including net holdings of the government and the Riksbank. Stock values are accumulated from flow data beginning in January 1982. The flows are defined in the following way,

$$\begin{aligned}\Delta RFX &\equiv \Delta NFA_g - \Delta NFA_c \\ &= E P_i i - P_x x - IN + OUT - \Delta NFA_p,\end{aligned}\quad (A2.1)$$

where ΔNFA_g is net foreign assets held by the government and ΔNFA_c is net foreign assets held by the central bank. Both are defined as debt minus liabilities. IN and OUT are exogenous inflows and outflows not recorded elsewhere. Source: RB.

- sd_i* Statistical discrepancy, where *i* refers to the variable determined by the identity. Since the linearization of the identities, as well as the transformation of the variables ruins the identities, a residual term is added to all identities in the model to make the left-hand side equal the right-hand side in every identity. This means that, during estimation, identities are treated as if they were exact identities, even after transformation of variables and linearization. The statistical discrepancy also includes all exogenous variables which might appear in the identity, see the following sections for details.
- v* Stock of inventories. The series is accumulated from a starting value of 83 494 MSEK in December 1981. Changes in inventories are calculated residually from the income identity. Source: BNP.
- y_d* Domestic income. Interpolated from quarterly data by using monthly industrial production index (IPI). The monthly values of GDP have been constructed with the following formula,

$$y_{q,m} = \frac{IPI_{q,m}}{\sum IPI_{q,m}} y_t \quad (q = 1, 2, 3), \quad (A2.2)$$

($t = 1982:1, 1982:2, \dots, 1988:6$),

where *m* is the first, the second and the third month of quarter *q*. Notice that this procedure leads to monthly estimates of income which are consistent with the official quarterly figures. Source: BNP.

yt Foreign income. Industrial production of Industrialized Countries, as defined in IFS series 11066C. Source: IFS.

All data series are seasonally adjusted by the X11 technique. The original variables in the quarterly national income identity were seasonally adjusted by Statistics Sweden. Exports, imports, prices and retail trade indices were adjustment from January 1975. The remaining series were adjusted from January 1982. All price indices are calculated with 1980 as the base year.

Starting with the government deficit identity, dividing both sides of this equation with GD and subtraction of the corresponding steady state expression, and remembering that in steady state $\rho_9 = \rho_8 = \rho_{16}$ and that $x = e^{\ln x}$, leads to,

$$\begin{aligned} Dx_{16} &= \frac{GE}{GD} - \frac{GE^* e^{\rho_9 t}}{GD^* e^{\rho_{16} t}} - \frac{T}{GD} - \frac{T^* e^{\rho_8 t}}{GD^* e^{\rho_{16} t}} \\ &= \frac{GE^*}{GD^*} (e^{x_9 - x_{16}} - 1) - \frac{T^*}{GD^*} (e^{x_8 - x_{16}} - 1). \end{aligned} \quad (A4:1)$$

This is a non-linear expression which can be linearized by expansion in Taylor expansions of each term around its steady state value, say x^* . Since $x^* = \log 1 = 0$ in steady state we get that $e^{x_9 - x_{16}} \approx 1 + x_9 - x_{16}$. Thus, A4:1 becomes,

$$Dx_{16} = \frac{GE^*}{GD^*} x_9 - \frac{T^*}{GD^*} x_8 + \left[\frac{T^*}{GD^*} - \frac{GE^*}{GD^*} \right] x_{16}. \quad (A4:2)$$

If we turn to the money supply identity, it can be written as,

$$\frac{DM}{M} \equiv D \log M = \frac{DGD}{M} - \frac{DB}{M} + \frac{DA}{M} - \frac{DRFX}{M}. \quad (A4:3)$$

If the corresponding steady state equation is subtracted from this identity the result is,

$$\begin{aligned} Dx_{15} &= D \log GD \frac{GD}{M} - \rho_{16} \frac{GD^*}{M^*} - \left[D \log B \frac{B}{M} - \rho_{13} \frac{B^*}{M^*} \right] \\ &+ D \log A \frac{A}{M} - \rho_{10} \frac{A^*}{M^*} \\ &- \left[D \log RFX \frac{RFX}{M} - \rho_{12} \frac{RFX^*}{M^*} \right]. \end{aligned} \quad (A4:4)$$

The next step is to rewrite the r.h.s. of in terms of x_i variables. Starting with the first term on the RHS of (A4:4), adding and subtraction of $D \log GD^* e^{\rho_{16} t} \frac{GD}{M}$ lead to,

$$\begin{aligned} & \frac{GD}{M} \left[Dx_{16} + \rho_{16} \left[1 - \frac{GD^* M}{M^* GD} \right] \right] \\ &= \frac{GD^*}{M^*} e^{x_{16} - x_{15}} \left[Dx_{16} + \rho_{16} \left[1 - \frac{1}{e^{x_{15} - x_{16}}} \right] \right]. \end{aligned} \quad (A4:5)$$

Linearization of an expression like $e^{x_{16} - x_{15}} x_i$ around a steady state point yields, $e^{x_{16} - x_{15}} x_i \approx x_i$, which is identical to $e^{x_{16} - x_{15}} Dx_j \approx Dx_j$. Hence we get,

$$(GD^* / M^*) [Dx_{16} + \rho_{16}x_{16} - \rho_{16}x_{15}]. \quad (A4:6)$$

Using similar techniques to linearize the remaining terms in the identity result in,

$$\begin{aligned} Dx_{15} &= (GD^* / M^*) [Dx_{16} + \rho_{16}x_{16}] - (B^* / M^*) [Dx_{19} + \rho_{13}x_{19}] \\ &+ (A^* / M^*) [Dx_{21} + \rho_{10}x_{21}] - (RFX^* / M^*) [Dx_{20} + \rho_{12}x_{20}] \\ &+ [(RFX^* / M^*) \rho_{12} + (B^* / M^*) \rho_{13} - (A^* / M^*) \rho_{15} \\ &- (GD^* / M^*) \rho_{16}] x_{15} \end{aligned} \quad (A4:7)$$

The transformation of the income identity provides problems similar to the ones above. The result is,

$$\begin{aligned} Dx_{17} &= \frac{y^*}{v^*} x_4 - \frac{c^*}{v^*} x_1 - \frac{x^*}{v^*} x_2 + \frac{i^*}{v^*} x_3 \\ &+ \left[\frac{c^*}{v^*} + \frac{x^*}{v^*} - \frac{i^*}{v^*} - \frac{y^*}{v^*} \right] x_{17}. \end{aligned} \quad (A4:8)$$

Finally we have the balance of payments identity. If we subtract the steady state identity and extend each expression within brackets we get,

$$(P_x x - P_x^* e^{\rho_6 t} x^* e^{\rho_2 t}) - (ES P_i i - ES^* P_i^* e^{\lambda_2 t} i^* e^{\rho_3 t})$$

$$\begin{aligned}
& + (DNFA - DNFA^* e^{\rho_{11}t}) + (DRFX - DRFX^* e^{\rho_{12}t}) \\
& = P_x^* x^* e^{(\rho_2 + \rho_6)t} \left[\frac{P_x x}{P_x^* e^{\rho_6 t} x^* e^{\rho_2 t}} - 1 \right] \\
& - P_i^* i^* e^{(\lambda_2 + \rho_3)t} \left[\frac{ES i}{ES^* i^* e^{\rho_3 t}} - 1 \right] \\
& + NFA^* e^{\rho_{11}t} \left[\frac{NFA}{NFA^* e^{\rho_{12}t}} \frac{DNFA}{NFA} - \rho_{11} \right] \\
& + RFX^* e^{\rho_{11}t} \left[\frac{RFX}{RFX^* e^{\rho_{12}t}} \frac{DRFX}{RFX} - \rho_{12} \right] = 0. \tag{A4:9}
\end{aligned}$$

The steady state growth rates in this identity are $\rho_{12} = \rho_{11} = \rho_6 + \rho_3 = \lambda_2 + \rho_2 = \lambda_2 + \beta_7 \lambda_1$, and all exponential terms cancel out leading to,

$$\begin{aligned}
& P_x^* x^* (e^{x_6 + x_2} - 1) - ES^* P_i^* i^* (e^{x_{18} + x_3} - 1) \\
& + NFA^* (e^{x_{11}} \text{Dlog } NFA - \rho_{11}) \\
& + RFX^* (e^{x_{12}} \text{Dlog } RFX - \rho_{12}) = 0. \tag{A4:10}
\end{aligned}$$

It remains to transform $\text{Dlog } NFA$ and $\text{Dlog } RFX$, which is done by adding and subtracting $e^{x_{11}} \text{Dlog } NFA^* e^{\rho_{11}t}$ and $e^{x_{12}} \text{Dlog } RFX^* e^{\rho_{12}t}$ to last two expressions in the equation,

$$\begin{aligned}
& P_x^* x^* (e^{x_6 + x_2} - 1) - ES^* P_i^* i^* (e^{x_{18} + x_3} - 1) \\
& + NFA^* [e^{x_{11}} \text{D}x_{11} + \rho_{11}(e^{x_{11}} - 1)] \\
& + RFX^* [e^{x_{12}} \text{D}x_{12} - \rho_{12}(e^{x_{12}} - 1)] = 0. \tag{A4:11}
\end{aligned}$$

After linearization we have,

$$P_x^* x^* (x_6 + x_2) - ES^* P_i^* i^* (x_{18} + x_3)$$

$$\begin{aligned}
& + NFA^{\circ} (Dx_{11} + \rho_{11}x_{11}) \\
& + RFX^{\circ} (Dx_{12} - \rho_{12}x_{12}) = 0,
\end{aligned} \tag{A4:12}$$

which, solved for x_{18} , yields

$$\begin{aligned}
x_{18} = & \frac{P_i^{\circ} x^{\circ}}{ES^{\circ} P_i^{\circ} i^{\circ}} (x_6 + x_2) - x_3 + \frac{NFA^{\circ}}{ES^{\circ} P_i^{\circ} i^{\circ}} (Dx_{11} + \rho_{11}x_{11}) \\
& + \frac{RFX^{\circ}}{ES^{\circ} P_i^{\circ} i^{\circ}} (Dx_{12} - \rho_{12}x_{12}).
\end{aligned} \tag{A4:13}$$

Table 1. Long-run relations.

Consumption

$$\log c^* = \log \gamma_1 + \beta_1 \log y_d - \beta_2 R_d \quad (1:1)$$

Exports

$$\log x^* = \log \gamma_2 + \beta_3 \log (ES P_f / P_x) + \beta_4 \log y_f \quad (1:2)$$

Imports

$$\log i^* = \log \gamma_3 + \beta_5 \log (P_d / ES P_i) + \beta_6 \log y_d \quad (1:3)$$

Income

$$\log y_d^* = \log \gamma_4 + \beta_7 \log y_f \quad (1:4)$$

Domestic price level

$$\log P_d^* = \log \gamma_5 + \beta_8 \log (ES P_f) \quad (1:5)$$

Export price level

$$\log P_x^* = \log \gamma_6 + \beta_9 \log (ES P_f) \quad (1:6)$$

Domestic interest rate

$$R_d^* = \gamma_7 + R_f + \log (EF/ES) \quad (1:7)$$

Nominal taxes

$$\log T^* = \log \gamma_8 + \beta_{10} \log (P_d y_d) \quad (1:8)$$

Nominal government expenditure

$$\log GE^* = \log \gamma_9 + \beta_{11} \log (P_d y_d) \quad (1:9)$$

Bank advances to the non-bank public

$$\log A^* = \kappa \quad (1:10)$$

Net foreign assets held by the private sector

$$\begin{aligned} \log NFA^* = & \log \gamma_{11} + \beta_{12} (R_d - R^*) + \beta_{13} \log (ET/ES) \\ & + \beta_{14} \log (P_d y_d) - \beta_{15} \log (ES P_f y_f) \end{aligned} \quad (1:11)$$

Net foreign assets held by the public sector

$$\log RFX^* = \log \gamma_{12} + \beta_{16} \log GD \quad (1:12)$$

Growth in non-bank holdings of government bonds

$$\log B = \gamma_{13} + \beta_{17} \log GD + \beta_{18} \log (ET/ES) \quad (1:13)$$

Expected exchange rate

$$\begin{aligned} \log EF^* = & \log \gamma_{14} + \beta_{19} \log (P_d/ET P_f) + \beta_{20} (R_d - R_f) \\ & + \beta_{21} \log ES \end{aligned} \quad (1:14)$$

Demand for money

$$\log M^* = \log \nu_1 + \beta_{22} \log (y_d P_d) - \beta_{23} R_d \quad (1:15)$$

Government debt

$$\log GD^* = \log \int (GE^* - T^*) dt \quad (1:16)$$

Demand for inventories

$$\log v^* = \log \nu_2 + \log y_d \quad (1:17)$$

Balance of payments (Exchange rate)

$$P_x^* x^* - ES^* P_1^* i^* + DNFA^* + DRFX^* = 0 \quad (1:18)$$

Table 2. The Adjustment Process.

$$\text{Dlog } c = \alpha_1 \log(c^*/c) - \alpha_2 \log(M^*/M) + \epsilon_1 \quad (2:1)$$

$$\text{Dlog } x = \alpha_3 \log(x^*/x) + \epsilon_2 \quad (2:2)$$

$$\text{Dlog } i = \alpha_4 \log(i^*/i) + \alpha_5 \log(v^*/v) + \epsilon_3 \quad (2:3)$$

$$\text{Dlog } y_d = \alpha_6 \log(y_d^*/y_d) + \alpha_7 \log(v^*/v) + \epsilon_4 \quad (2:4)$$

$$\text{Dlog } P_d = \alpha_8 \log(P_d^*/P_d) + \epsilon_5 \quad (2:5)$$

$$\text{Dlog } P_x = \alpha_9 \log(P_x^*/P_x) + \epsilon_6 \quad (2:6)$$

$$\text{DR}_d = \alpha_{10} (R^* - R_d) + \epsilon_7 \quad (2:7)$$

$$\text{Dlog } T = \alpha_{11} \log(T^*/T) + \epsilon_8 \quad (2:8)$$

$$\text{Dlog } GE = \alpha_{12} \log(GE^*/GE) + \epsilon_9 \quad (2:9)$$

$$\text{Da} = \alpha_{13} [\log \gamma_{10}(M^*/M) - a] + \epsilon_{10} \quad (2:10)$$

$$\text{Dlog } NFA = \alpha_{14} \log(NFA^*/NFA) + \epsilon_{11} \quad (2:11)$$

$$\begin{aligned} \text{Drfx} = & \alpha_{15} \alpha_{16} \log(RFX^*/RFX) - \alpha_{15} \text{rfx} \\ & - \alpha_{17} \log[ET/ES e^{\beta_{24} \text{DUM1}}] + \epsilon_{12} \end{aligned} \quad (2:12)$$

$$\begin{aligned} \text{Db} = & \alpha_{18} \alpha_{19} \log(B^*/B) - \alpha_{18} b \\ & - \alpha_{20} \log(M^*/M) + \epsilon_{13} \end{aligned} \quad (2:13)$$

$$\text{Dlog } EF = \alpha_{21} \log(EF^*/EF) + \epsilon_{14} \quad (2:14)$$

$$\text{DM} = \text{DGD} - \text{DB} + \text{DA} - \text{DRFX} + \text{SDM} \quad (2:15)$$

$$\text{DGD} = \text{GE} - \text{T} + \text{SDG} \quad (2:16)$$

$$\text{Dv} = y_d - c - x + i + sd_v \quad (2:17)$$

$$P_x x - \text{ESP}_1 i + \text{DNFA} + \text{DRFX} + \text{SDE} = 0 \quad (2:18)$$

$$\text{Dlog } B = b$$

(2:19)

$$\text{Dlog } RFX = \text{rfx}$$

(2:20)

$$\text{Dlog } A = a$$

(2:21)

Table 3. List of variables.

Endogenous variables

<i>A</i>	bank advances to non-bank private sector
<i>a</i>	rate of growth in bank advances
<i>B</i>	government bonds held by non-bank private sector
<i>b</i>	rate of growth in government bonds held by non-bank private sector
<i>c</i>	real private consumption, interpolated from quarterly figures using monthly retail sales index
<i>EF</i>	expected foreign exchange rate, approximated with an effective 3-month forward exchange rate index, constructed in the same way as <i>ES</i>
<i>ES</i>	effective spot exchange rate index
<i>GE</i>	government expenditure, (consumption and investments)
<i>GD</i>	government debt
<i>i</i>	real imports of goods and services
<i>M</i>	stock of money (M3)
<i>NFA</i>	net foreign assets held by the private sector, (debt – liabilities)
<i>P_d</i>	domestic price level, CPI
<i>P_x</i>	price of exports
<i>R_d</i>	domestic interest rate, three months Treasury Discount Note rates
<i>RFX</i>	net foreign assets held by the public sector, Riksbanken and the government (debt – liabilities).
<i>rfx</i>	rate of growth in net foreign assets held by the public sector
<i>T</i>	total nominal taxes
<i>v</i>	real inventories, accumulated from changes in inventories, the latter calculated residually from income identity
<i>x</i>	real exports of goods and services
<i>y_d</i>	real domestic income, interpolated from quarterly GDP and monthly industrial production index

Exogenous variables

<i>ET</i>	mid-point of target zone for the foreign exchange rate index
<i>P_f</i>	foreign price level, CPI for Industrial countries
<i>P_i</i>	import prices
<i>R_f</i>	foreign interest rate, three month Eurodollar rate. (London)
<i>SDM</i>	statistical discrepancy, includes all non-explained items in the money supply identity (<i>EXCM</i>) ^a
<i>SDg</i>	statistical discrepancy, includes all non-explained items in the identity ^a
<i>sd_v</i>	statistical discrepancy, includes (<i>igcy</i>), investments of all sectors, consumption of the public sector, and various "correction terms". ^a
<i>SDE</i>	statistical discrepancy, includes non-explained inflows (<i>IN</i>) and outflows (<i>OUT</i>) in the balance of payments ^a
<i>y_f</i>	real foreign income, industrial production index of Industrial countries
<i>DUM1</i>	Dummy variable for Jun85–Jun88

^aFor details see Appendix II.

Table 4. Steady state growth rates of endogenous variables.

c, x, i, y_d, v	$\beta_7 \lambda_1$
P_d	λ_2
P_x	$\lambda_3 = \beta_9 \lambda_2$
$T, GE, A, NFA,$ RFX, B, M, GD	$\beta_{22}(\lambda_2 + \beta_7 \lambda_1)$
R_d, ES, EF	0

Table 5. Steady state constraints on parameters.

$\beta_1 = 1.0$
$\beta_8 = 1.0$
$\beta_{10} = \beta_{11} = \beta_{22}$
$\beta_{16} = 1.0$
$\beta_{17} = 1.0$

Table 6. Adjustment (α) parameters.

	Estimate	St.dev	'T-value'	Lag ^a	Equation
α_1	2.680	0.508	5.28	11 days	: 1 Consumption
α_2	1.491	0.406	3.67		: 1
α_3	6.497	1.592	4.08	5 days	: 2 Exports
α_4	2.612	0.531	4.92	11 days	: 3 Imports
α_5	0.693	0.217	3.19		: 3
α_6	1.004	0.235	4.26	30 days	: 4 Income
α_7	0.209	0.056	3.71		: 4
α_8	0.034	0.016	2.13	880 days	: 5 Dom. price
α_9	0.116	0.023	5.00	260 days	: 6 Exp. price
α_{10}	0.289	0.109	2.64	100 days	: 7 Interest rate
α_{11}	6.467	1.568	4.12	5 days	: 8 Taxes
α_{12}	5.814	1.436	4.05	5 days	: 9 Gov.expenditure
α_{13}	0.827	0.116	7.13	36 days	:10 Advances
α_{14}	0.046	0.014	3.26	650 days	:11 Net for. assets
α_{15}	1.398	0.355	3.94		:12 Net for. reservs
α_{16}	0.221	0.077	2.87		:12
α_{17}	3.355	1.700	1.97		:12
α_{18}	0.784	0.185	4.23		:13 Bonds
α_{19}	1.051	0.408	2.57		:13
α_{20}	0.826	0.312	2.66		:13
α_{21}	3.385	0.983	3.90	9 days	:14 Expected <i>ES</i>

^aLag is the mean time lag ($1/\alpha$), which measures the time necessary to close 63% of the gap between the target and the actual value, under the assumption that the spillover from other deviations from targets included in the same equation is zero. The mean time lags in days are calculated as $(1/\alpha) \times 30$.

Table 7. Long-run (β) parameters.

	Estimate	St.dev	'T-value'	Equation
β_1	0.839	0.0955	8.79	: 1 Consumption
β_2	3.835	0.983	3.90	: 1
β_3	0.625	0.157	3.99	: 2 Exports
β_4	0.990	0.058	17.21	: 2
β_5	0.389	0.092	4.21	: 3 Imports
β_6	1.0 ^R			: 3
β_7	0.520	0.064	8.11	: 4 Income
β_8	0.726	0.292	2.49	: 5 Domestic price
β_9	0.647	0.0776	8.34	: 6 Export Price
β_{10}	1.204	0.153	7.89	: 8 Taxes
β_{11}	0.488	0.055	8.83	: 9 Gov. expenditure
β_{12}	354.173	122.480	2.89	:11 Net for. assets
β_{13}	51.935	20.274	2.56	:11
β_{14}	1.0 ^R			:11
β_{15}	1.0 ^R			:11
β_{16}	1.431	0.448	3.20	:12 Net for. reserves
β_{17}	1.504	0.046	32.77	:13 Bonds
β_{18}	2.732	1.035	2.64	:13
β_{19}	0.038	0.015	2.56	:14 Expected <i>ES</i>
β_{20}	1.112	0.092	12.05	:14
β_{21}	0.925	0.023	40.91	:14
β_{22}	0.445	0.034	13.23	: 1, 10, 13
β_{23}	6.502	0.870	7.47	: 1, 10, 13
β_{24}	7.854	3.464	2.27	:12

^RRestricted value.

Table 8. Constants.

Equation	Estimate	S.dev	'T-value'
1	7.033	2.914	2.41
2	9.093	4.090	2.22
3	2.056	0.434	4.74
4	-7.363	1.361	5.41
5	-0.004	0.004	0.96
6	-0.007	0.003	1.87
7	-0.001	0.000	2.20
8	18.567	9.804	1.89
9	-21.547	5.911	3.64
10	-5.222	0.757	6.90
11	-0.406	0.114	3.03
12	2.232	1.223	1.83
13	9.945	2.726	3.65
14	-0.026	0.010	2.57

Table 9. Residual variances and system R².

Variable	Equation	Variance of structural residual	Variance of endogenous variable	Mean Square error
Δc	1	0.002510	0.000902	0.000489
Δx	2	0.025930	0.004983	0.001358
Δi	3	0.010085	0.003372	0.001723
Δy_d	4	0.000210	0.000209	0.000105
ΔP_d	5	0.000017	0.000018	0.000017
ΔP_x	6	0.000015	0.000018	0.000014
ΔR_d	7	0.000003	0.000002	0.000001
ΔT	8	0.924598	0.211945	0.051206
ΔGE	9	0.103205	0.021694	0.006863
$\Delta^2 A$	10	0.000673	0.000068	0.000274
ΔNFA	11	0.002894	0.000450	0.000451
$\Delta^2 RFX$	12	0.005739	0.000467	0.000484
$\Delta^2 B$	13	0.001803	0.001343	0.000808
ΔEF	14	0.000215	0.000124	0.000063

Table 10. Estimated eigenvalues from equations 15:1 – 15:21.

Eigenvalue		Standard errors		Damping period ^a	Period of cycle ^a
real	imaginary	real	imaginary		
1	0.019	0.183		51.37	
2	-0.003	0.000		306.07	
3	-0.036	0.018		27.64	
4	-0.109	0.008		9.14	
5	-0.178	0.044		5.63	
6	-0.755	0.042		1.32	
7	-1.119	0.117		0.89	
8	-1.150	0.121		0.87	
9	-1.489	0.001		0.67	
10	-1.502	0.019		0.66	
11	-1.528	0.001		0.65	
12	-1.783	0.015		0.56	
13	-2.000	0.000		0.50	
14	-0.389	±0.176	0.053	2.57	35.66
15	-0.628	±0.279	0.134	1.59	22.52
16	-0.673	±0.660	0.023	1.48	9.53
17	-0.776	±0.131	0.104	1.29	48.10

^aMeasured in months

Table 11. Sensitivity analysis.

Panel A

Equation		y	P_d	P_x	a
Eigenvalue		$\delta\mu/\delta\alpha_7$	$\delta\mu/\delta\alpha_8$	$\delta\mu/\delta\alpha_9$	$\delta\mu/\delta\alpha_{13}$
1	0.019	.	-0.013	.	.
3	-0.036	.	-1.088	.	.
4	-0.109	.	.	-0.879	.
14	-0.389	.	.	.	-0.342
	0.176i	.	.	.	-0.256
17	-0.776	-0.709	.	.	.
	0.131i	-0.313	.	.	.

Panel B

Equation		R_d	NFA	rfx	EF	EF	EF
Eigenvalue		$\delta\mu/\delta\alpha_{10}$	$\delta\mu/\delta\alpha_{14}$	$\delta\mu/\delta\alpha_{16}$	$\delta\mu/\delta\beta_{19}$	$\delta\mu/\delta\beta_{20}$	$\delta\mu/\beta_{21}$
1	0.019	0.066	.	.	-0.033	0.176	0.072
4	-0.109	.	.	.	-0.070	.	.
5	-0.177	.	-1.092	-0.726	.	.	.
12	-1.782	.	2.595	0.000	.	.	.
15	-0.628	.	1.070	-0.211	.	.	0.620
	0.279i	.	-2.359	0.264	.	.	0.273
17	-0.776	.	0.189	0.209	.	.	.
	0.131i	.	-0.594	-0.097	.	.	.

Table 12. Bifurcation points.

Panel A^a

Equation	y	P_d	P_x	a
Eigenvalue	α_7	α_8	α_9	α_{13}
1	0.019	.	0.023 1.462 0.034 1.496	.
3	-0.036	.	1.028* -0.030 0.034 0.004	.
4	-0.109	.	0.935* -0.124 0.116 -0.001	.
14	-0.389	.	.	0.727 -1.137 0.827 -0.310
17	-0.776	0.191 -1.094 0.209 -0.885	.	.

^aThe first value is the elasticity of the eigenvalue with respect to the parameter, the second is the change in the parameter needed to make the eigenvalue zero, the third value is the estimated parameter and the last the predicted bifurcation point. A star indicates an elasticity above or close to unity.

Table 12 continued.
Panel B^a

Equation	R_d	NFA	rfx	EF	EF	EF
Eigenvalue	$\delta\mu/\delta\alpha_{10}$	$\delta\mu/\delta\alpha_{14}$	$\delta\mu/\delta\alpha_{16}$	$\delta\mu/\delta\beta_{19}$	$\delta\mu/\delta\beta_{20}$	$\delta\mu/\beta_{21}$
1	0.019	1.004*	.	0.066	10.300*	3.505*
	-0.288	.	.	0.576	-0.108	-0.264
	0.289	.	.	0.038	1.112	0.925
	0.001	.	.	0.614	1.004	0.661
4	-0.109	.	.	0.140	.	.
				-1.557		
				0.038		
				-1.519		
5	-0.097	.	0.284	0.906*	.	.
		-0.162	-0.244	.	.	.
		0.046	0.221	.	.	.
		-0.116	-0.023	.	.	.
12	-1.782	.	0.067	.	.	.
			0.687	.	.	.
			0.046	.	.	.
			0.733	.	.	.
15	-0.628	.	0.078	0.074	.	0.913*
			0.587	-2.976	.	1.013
			0.046	0.221	.	0.925
			0.633	-2.893	.	1.984
17	-0.776	.	0.011	0.060	.	.
			4.106	3.713	.	.
			0.046	0.221	.	.
			4.152	3.934	.	.

^aThe first value is the elasticity of the eigenvalue with respect to the parameter, the second is the change in the parameter needed to make the eigenvalue zero, the third value is the estimated parameter and the last the predicted bifurcation point. A star indicates an elasticity above or close to unity.

Sammanfattning

Uppsatsen studerar den Svenska ekonomins anpassningsprocess under perioden 1982–1988. Syftet är att identifiera faktorer som verkar stabiliserande alternativt destabiliserande, på anpassningsprocessen givet det rådande fasta valutakurssystemet och den förda stabiliseringspolitiken. Resultaten bygger på en ekonometrisk makromodell i kontinuerlig tid som linjäriseras runt sitt dynamiska jämviktsläge (steady state). Resultaten tyder på att ekonomins stabilitet är mycket känslig för anpassningshastigheten i priser och räntor. En slutsats är att störningar i dessa variabler snabbt ger upphov till devalveringsförväntningar, eftersom deras dynamiska jämviktslägen bestäms i relation till utländska variabler, givet den fasta växelkursen. *Ceteris paribus* verkar en långsammare anpassning i inhemska priser mot utländska prisnivåer destabiliserande på ekonomin, medan en långsammare anpassning av inhemska räntor är stabiliserande. Det senare kan tolkas som, att i den mån Riksbanken har fördröjt anpassningsprocessen har detta verkat stabiliserande på ekonomin. Vad gäller effekterna av en liberalisering av kapitalrörelserna tyder resultaten på att ekonomin är relativt okänslig för förändringar i kapitalbalansens anpassningshastighet. *Ceteris paribus*, leder en avreglering av valutamarknaden inte till ökad destabilitet.

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